Maximizing Training Effectiveness using PC-Based Games

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Abstract: Research shows that first-person-perspective PC-based games are intrinsically motivating and can facilitate training. The goal of this research was to better understand what components of PC-based games are most effective for training. The design used a within-subject design to assess how information presented during first-person-perspective games impacts the retention of that information. In the game used for this experiment, players assumed the role of a new soldier going through basic training. The types of information presented during the game were categorized along two dimensions: 1) type of information (i.e., factual, procedural, and episodic) and 2) relevance to game-play (for example, does the information help a player progress through the game scenario). After participants played the PC-based game for approximately 1 hour, they answered questions regarding the content of the game. Results indicated that participants were most likely to recall procedural information followed by episodic and then factual information. Regarding relevance to game-play, participants were more likely to recall information that either was required or helpful for player progress in the game compared to information that was tangential to the game's objectives. The results of this research provide guidelines about how training developers may take advantage of first-person-perspective, PC-based games.

Introduction

A broad range of research has demonstrated that PC-based games are intrinsically motivating and can facilitate learning (Prensky, 2001). Research has also indicated that skills learned with PC-based games will transfer to real-life situations (Gopher, Weil, & Bareket, 1994; Knerr, Simutis, & Johnson, 1979). This suggests that learning while playing PC-based games is possible, but how can we maximize the effectiveness of this training medium? The goal of this research was to better understand what components of PC-based games are most effective for training purposes.

The majority of research on how to improve PC-based training games has focused the factors that hold a player's attention and motivate them to invest a lot of time playing (Corbeil, 1999). Although this may be an important component for training games, the focus has shifted to how to make a game fun and enjoyable, rather than how to make the game an effective training tool. The disparity between fun and training effectiveness is important; a training game can be fun but not teach anything. The opposite is also possible, a training game may be very educational, but so dry and boring that few learners will engage the game long enough to achieve the learning objectives.

One way to maximize the effectiveness of training games is to determine the components of PC-based games that make them effective as a conduit for training. The medium of PC-based games allows for many different types of information to be presented, but not much research has investigated how the presentation of information and how the information relates to the theme of the game may impact learning. This is surprising, given the many choices training developers have at their disposal. The current research was conducted to assess the potentially differential effects of information presentation on learning outcomes in a PC-based training game environment.

The game used in this research was a first-person perspective game, chosen because of it's popularity, high fidelity, and ability to engage the player. Over a million players have registered online to play the game, America's Army. In the game players assumed the role of a new soldier going through basic training. This game was released as a recruiting tool: designed for potential recruits to understand what they should expect during basic training and learn about Army core values, Army history, and Army background. The game was not designed to train military skills.

Method

The types of information presented during the game were categorized along two dimensions: 1) type of information (i.e., factual, procedural, and episodic), and 2) relevance to game-play (e.g., does the information help a player progress through the game scenario). Along the first dimension: procedural information was defined as knowledge of a skill or activity (cognitive or motor); factual information was defined as knowledge that one represents through language, such as facts and concepts; and episodic information was defined as knowledge of past events, experiential memories of sensation and perception. Along the second dimension, relevance, information was categorized as either relevant to game-play or not relevant to game-play. Relevance to game-play was considered as information that was either required or helpful to progress through the game, and information that had no impact on game performance was considered not relevant to game-play.

For the experiment, a within-subject design was used to assess how information presented during this first-person-perspective game impacted retention of that information. The participants for the experiment were 10 recruits of the US Army who had not yet reported for duty. Their ages ranged from 18 to 29 years old.

The participants were first given a pretest, which consisted of a demographics section including questions regarding prior gaming experience and a 9-item multiple-choice pre-test assessing US Army knowledge and experience with the game. Following the pre-test, participants played the PC-based game. On average, it took the participants approximately 1 hour to complete the four sections of the game considered "basic training". After playing the game, participants completed a 35-item multiple-choice post-test on the content of the game. They were also asked several open-ended questions concerning their playing experience and what would motivate them to continue playing the game.

Results and Discussion

For the post-test, learning outcomes were measured by a deviation score: the overall percentage of correctly answered questions was subtracted from the percentage of correctly answered questions of a particular type. For example, to determine the deviation from the mean score for procedural questions, the percentage of all correctly answered questions for one subject was subtracted from the percentage of correctly answered questions regarding procedural information. This procedure allowed us to compare the deviations across participants, accounting for overall differences in test scores between participants. This served as the dependent variable when investigating the differences between modes of presentation.

Results indicate that participants were most likely to recall procedural information followed by episodic and then factual information, see Figure 1. Compared to the overall percentage of questions answered correctly, questions about procedural information were 11 percent more likely to be answered correctly, questions on episodic information were 5 percent more likely to be answered correctly, and factual information was 9 percent less likely to be recalled. A pairwise comparison ANOVA, indicated a statistically significant difference ($p<.05$) between procedural and factual scores. These findings suggest that PC-based games would be more effective to train active tasks and sequences than the memorization of facts.

One aspect of a PC-based game is that the player can actively manipulate the environment. The results of this experiment indicate that this active manipulation may lead to improved retention, suggesting that game environments provide a rich context for learning procedures. This finding supplements the findings of James, Humphrey, Vilis, Corrie, Baddour, and Goodale (2002) who found that player controlled interaction with virtual environments leads to greater learning as compared to passive learning of the same material.

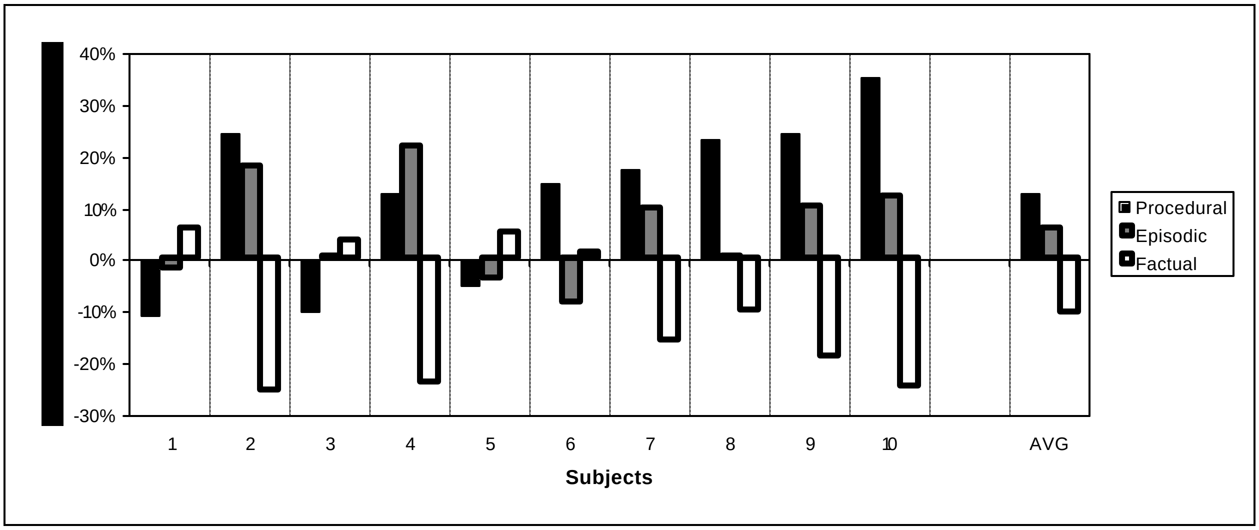

Figure 1: The percent deviations for each type of information for each subject. The last column to the right shows the average for all subjects.

Data also indicated that participants were more likely to recall information that was relevant to player progress in the game compared to information that was tangential to the game's objectives, see Figure 2. Compared to the overall percentage of questions answered correctly, questions relevant to game-play were 8 percent more likely to be answered correctly and questions not relevant to game-play were 15 percent less likely to be answered correctly, a statistically significant difference ($p<.05$).This indicates that the learning objects of the training should be weaved into the plot of the game, so that they seem relevant to the learner. In some training games, the game itself is used as a reward for going through the training information. For example, after completing a learning objective in computer-based, page-turner, the user is then allowed to play a game. In such a case, the findings of the current research would indicate that the players might be more likely to remember the reward (i.e., the game component) than what they were rewarded for (i.e., training content). Therefore, the game content should be directly related to the learning content.

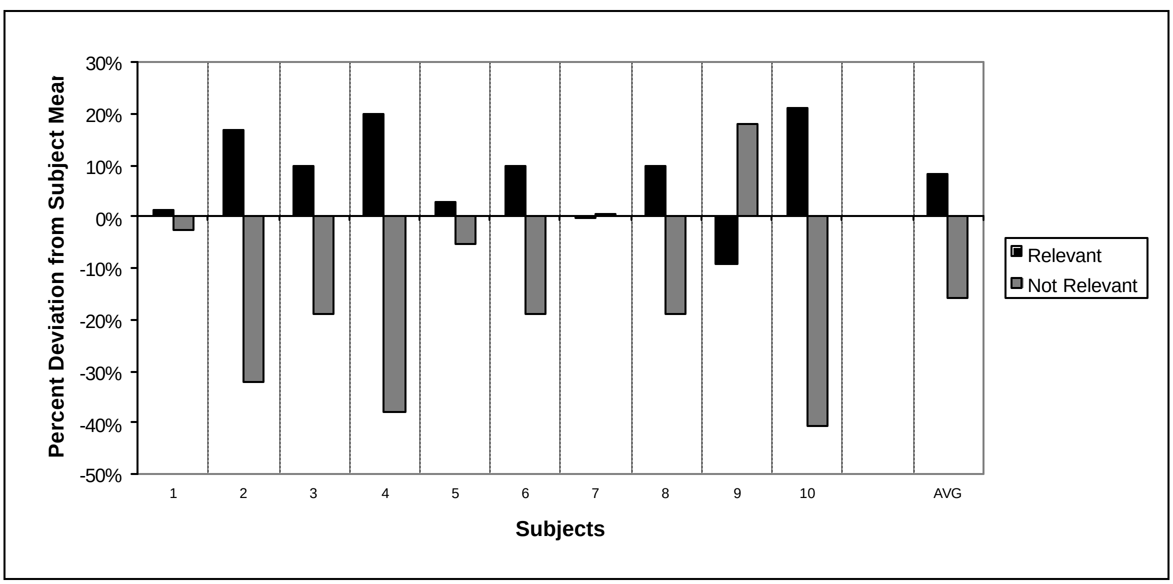

Figure 2: The percent deviations for information relevance to game-play for each subject. The last column to the right shows the average for all subjects.

An important point to be made is that there was a correlation between procedural information and information relevant to game-play. Retention may be a factor of the type of information, the relevancy of that information, and/or a combination. Future research should investigate the relationship between content and relevancy of information.

The two most common responses to what would motivate the players to continue playing the game were realism (a feeling of being immersed in the game) and challenge of the required tasks. . One of the realistic components of the game, which several participants commented on, was how a player's view changed due to their breathing. This added a realistic touch. High quality graphics are not the only way game developers can accomplish realism; they can also get an immersive feel to the game through natural motion. Regarding the level of challenge, participants seemed to like moderately difficult sections; the parts of the game that they liked the least they indicated were either too hard or too easy. The findings of this research corroborate Malone (1981), who found that realism and challenge are two of the aspects of instructional games that are intrinsically motivating for players. Future research may want to investigate levels of challenge and learner motivation.

Conclusion

PC-based games seem to be well suited for training procedural tasks. The results of this research provide guidelines about how training developers may take advantage of first-person-perspective gaming technology. First, they should incorporate the learning objectives into the theme of the game, so that they are relevant to game play. There must be an element of sensemaking, such that the learner understands the link between the information and its application to a task or environment. If that link is not made and information seems irrelevant, it is more likely to be forgotten. However, if the learner is able to understand the outcomes of using/understanding information, then they are more likely to retain it. Second, the technology needs to draw in players and keep them motivated to continue playing. This can be done by making the game immersive through realism and providing them with moderately challenging tasks. The third guideline for training developers is to consider, the type of information to be presented. Participants in this research were more likely to retain procedural and episodic information. They were much less likely to retain factual information. At this point, the research provides a better understanding of how to maximize the effectiveness of PC-based training games.

References

Corbeil, P. (1999). Learning from the children: Practical and theoretical reflections on playing and learning. *Simulation & Gaming, 30(2),* 163-180.

Gopher, D., Weil, M., & Bareket, T. (1994). Transfer of skill from a computer game trainer to Flight. *Human Factors, 36(3),* 387-405.

James, Humphrey, Vilis, Corrie, Baddour, & Goodale (2002). "Active" and"passive" learning of three-dimensional object structure within an immersive virtual reality environment. *Behavior Research Methods, Instruments, & Computers, 34(3),* 383-390.

Knerr, Bruce, W., Simutis, Zita M., & Johnson, Richard M. (1979). Computer-based simulations for maintenance training: current ARI research (Technical Report 544). US Army Research Institute for the Behavioral and Social Sciences: Alexandria, VA.

Malone, T. (1981). Towards a theory of instrinsically motivating instruction. Cognitive Science, 4, 333-369.

Prensky, Marc (2001). *Digital Game-Based Learning.* New York: McGraw-Hill.